Part I: obs4MIPs (P. Gleckler)
Part II: input4MIPs (P. Durack)

ESGF F2F 2017, Sheraton Fisherman's Wharf, San Francisco

Tuesday 5th December 2017

PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON (PCMDI)
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An Update on obs4MIPs from an ESGF perspective: progress plans and challenges

WDAC Observations for Model Evaluation Task Team

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Otis Brown (WDAC), Michel Rixen (WCRP), Sophie Cloché (IPSL), Tsengdar Lee (NASA) and Renu Joseph (DOE),

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Denis Nadeau (PCMDI) – CMOR3 development, Paul Durack (PCMDI) - obs4MIPs controlled vocabulary,

Jim Biard (NCEI) and Matthias Tuma (WCRP)

… and others

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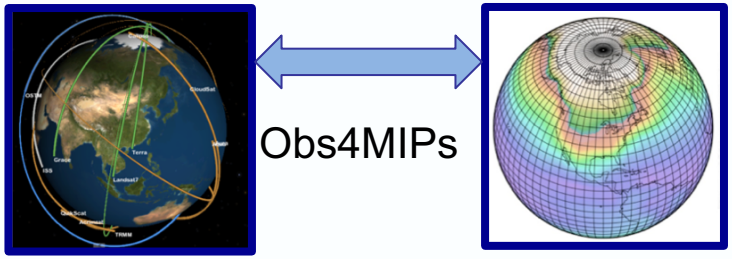
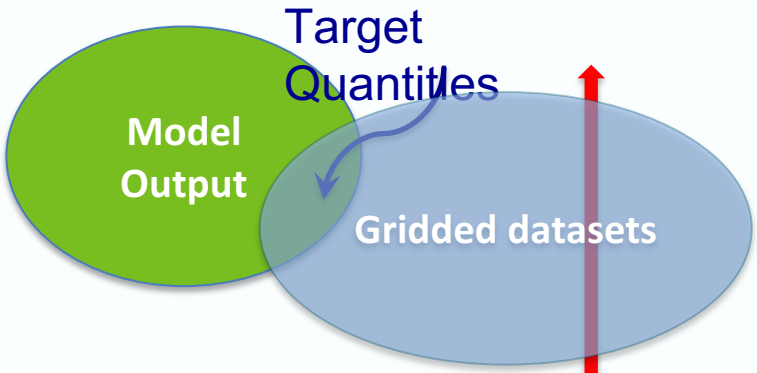
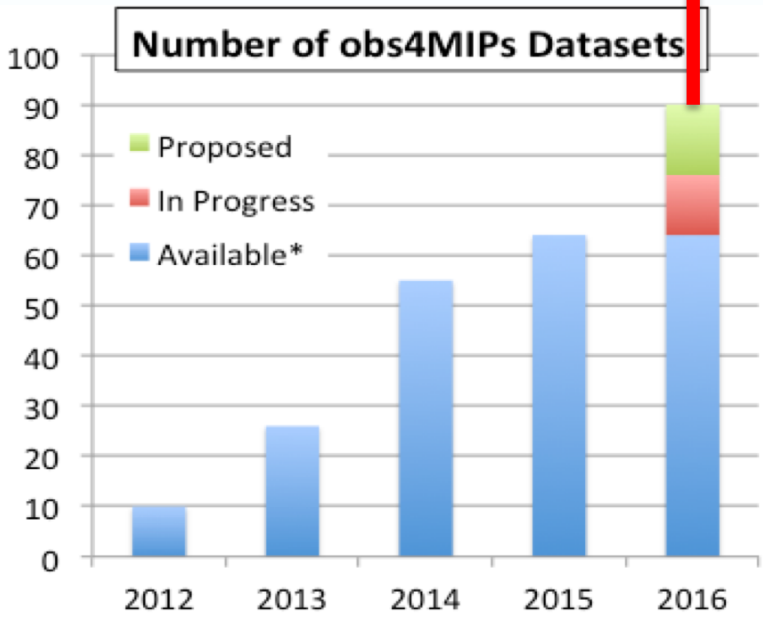
obs4MIPs

https://www.earthsystemcog.org/projects/obs4mips/



- A Project for identifying, documenting and disseminating observations for climate model evaluation.
- Data sets accessible on the ESGF alongside CMIP model output, **adhering to the same data conventions**
- Guided by the WCRP Data Advisory Council obs4MIPS Task Team





.... and growing!

Progress since ESGF F2F #6

(the not so good news)

New entries to obs4MIPs essentially stalled, awaiting…

- **CMIP6 global attributes, DRS, filenames, directory structure and CVs**
  - **Updating obs4MIPs data specifications to match CMIP6**
    - **Management of obs4MIPs CMOR tables and CVs on github**
      - **CMOR refinements**
        - **process documentation, beta testing**
          - **ready for data providers**

Progress since ESGF F2F #6

(**more recently… the good news!**)

- **CMIP6 global attributes, DRS, filenames, directory structure and CVs ✓**
  - **obs4MIPs data specifications* (ODS 2.1) ✓**
- **Management of obs4MIPs CVs on github ✓**
- **Additional CMOR enhancements to deal with gridded observations ✓**
  (now being used for new NOAA and ESA contributions)
- **Establishment of two new features ✓**
  - **Dataset "suitability indicators" ✓**
  - **Introduction of "supplemental information" ✓**

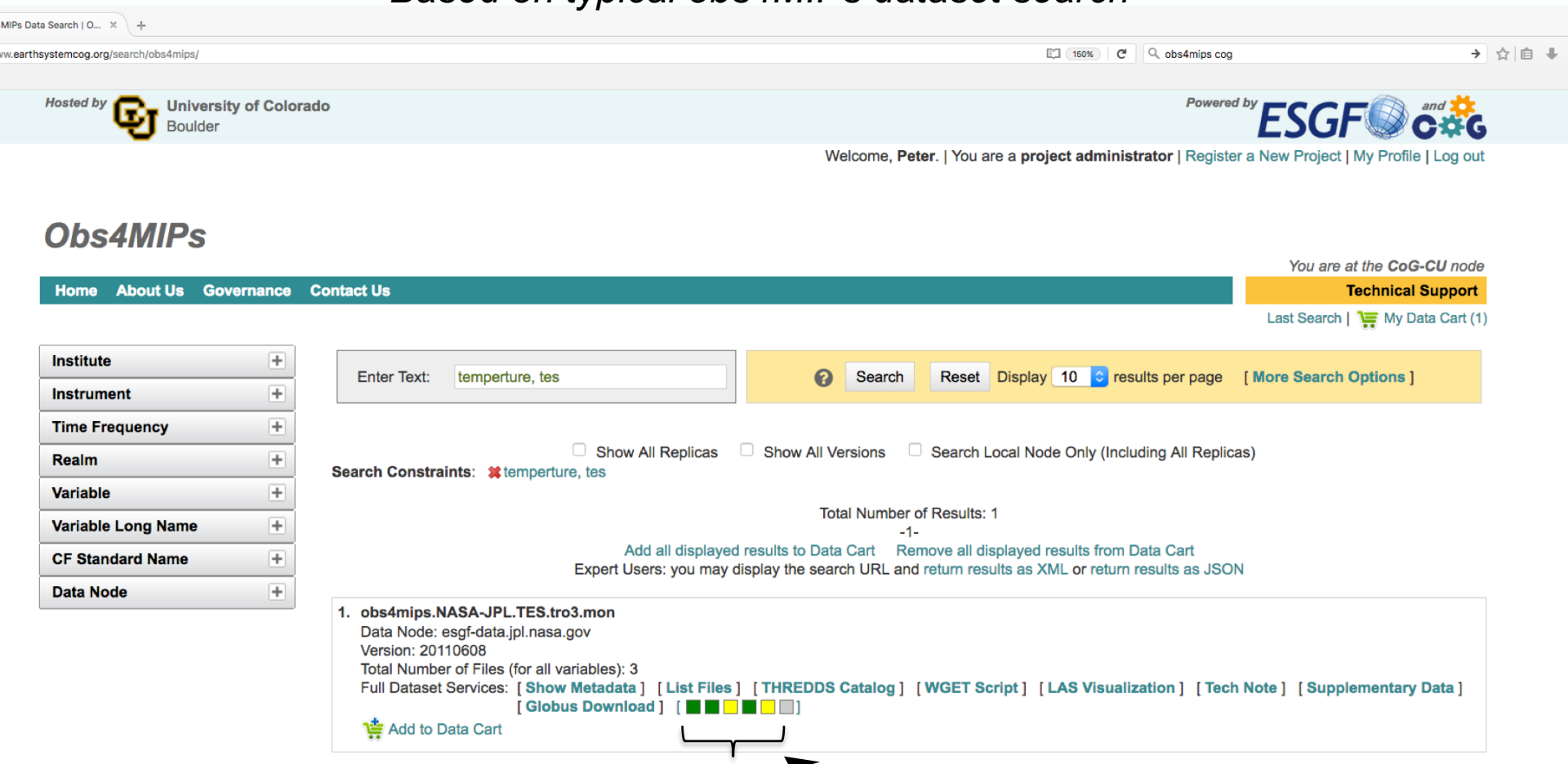
* Includes placeholders for ES-DOC and DKRZ publication service

obs4MIPs Dataset Suitability & Maturity Indicators

Technical Requirements		***Dataset Suitability and Maturity***			***Comparison Complexity***
Meets obs4MIPs data technical requirements	Includes obs4MIPs technical note information	Closeness or robustness of measurement to observed reference quantity	Maturity with respect to climate model evaluation	Provision for robust uncertainty information	Complexity of Model Observation Comparison
Data suitably processed with CMOR and/or consistent with obs4MIPs standards	Complete technical note information provided	Measurement approach provides a very close relationship to observation quantity	Multiple peer-reviewed examples of application to climate model evaluation	Uncertainty information provided per retrieval/grid point	Comparison can be made directly with CMIP model output variable
Largely complete with minor metadata inconsistencies	Technical note information incomplete and/or could be improved	Measurement approach requires complex and/or non-linear retrieval methods and/or subjective inferences/definitions	One peer-reviewed example of application to climate or component model evaluation.	General uncertainty information given relative to the methodology and dataset as a whole - backed by actual field/in-situ validation exercises	Comparison requires some simple post processing of CMIP output variable(s) (e.g. vertical integral or ratio of two variables)
Non-compliant. Should be removed from database!	Technical note not provided	Measurement approach requires significant use/influence from complex or weakly constrained model and/or has significant ambiguity in definition(s)	No peer-reviewed xamples of application to model evlauation	No uncertainty information provided	**Comparison requires complex processing of CMIP output (e.g. "simulator", budget calculation)**

Illustration Of Dataset Suitability And Maturity Indicators

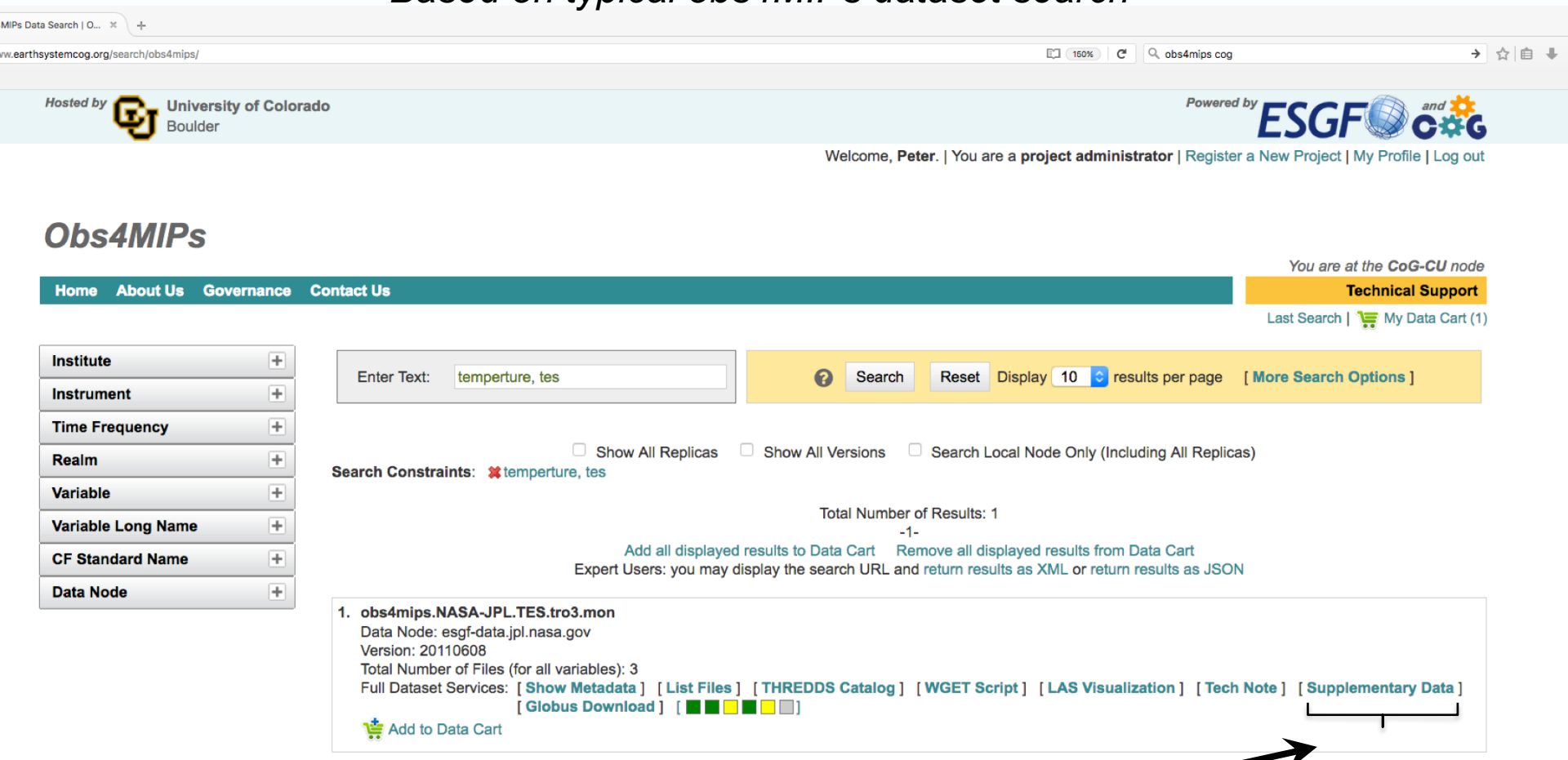
Based on typical obs4MIPs dataset search



Linked as a single entity to explanatory page of color codes

Illustration Of Dataset Suitability And Maturity Indicators

Based on typical obs4MIPs dataset search



Access to SUPPLEMENTAL DATA (in zip file; instructions available)

Example: obs4MIPs “registered content”: (Data providers enter as github issue)


```
"NOAA-NCEI-ERSST-4-0":{
    "institution_id":"NOAA-NCEI",
    "region":[
        "global_ocean"
    ],
    "release_year":"2015",
    "source_description":"Extended Reconstructed Sea Surface Temperatures",
    "source_id":"NOAA-NCEI-ERSST-4-0",
    "source_label":"NOAA-NCEI-ERSST",
    "source_name":"NOAA NCEI ERSST",
    "source_type":"gridded_insitu",
    "source_variables":[
        "tos"
    ],
    "source_version_number":"4.0"
},
```

Questions..

Q: What are the key things that are difficult to do today and are impeding scientific progress or productivity?

A: Preparing and publishing data

Q: What are key development effort that you see are needed for the future success of your projects?

A: Streamlining the process of contributing data

Q: What is the estimated size of your distributed archive?

A: ~Terabytes

Q: **What are the administrative/sponsor requirements that arise from your project?**

A: Usage metrics, persistent and digital object identifiers, dataset version control

Q: What are your expected strategic roadmaps for the ESGF's short, mid and long term development efforts?

A: 1-3 years: Get caught up, including updating existing datasets, with new data specifications (ODS 2.1)

3-5 years: Get a majority of gridded data used for model evaluation research in obs4MIPs

5-10 years: It is possible, with sufficient progress, that obs4MIPs or a similar effort will revolutionize how data are coordinated across agencies, borders, and classes of data

obs4MIPs: Current ESGF strategic needs

- Smooth transition to new facets/datasets; backwards compatibility with existing data
- Remove or filter unwanted data (by whom?)
- Planning for in-situ data

input4MIPs: Boundary Conditions and Forcing Datasets for CMIP6

DOE ESGF F2F 2017, Sheraton Fisherman's Wharf, San Francisco

Paul J. Durack, Karl E. Taylor, Sasha Ames, Tony Hoang, Martina Stockhause and many others..

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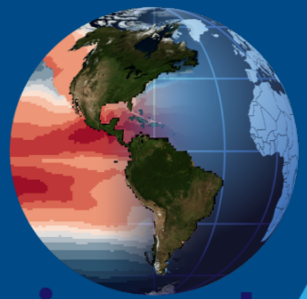
Section 0:
What is input4MIPs?
Observationally-derived input datasets for Model Intercomparison Projects (MIPs)



input4MIPs
input datasets for Model Intercomparison Projects

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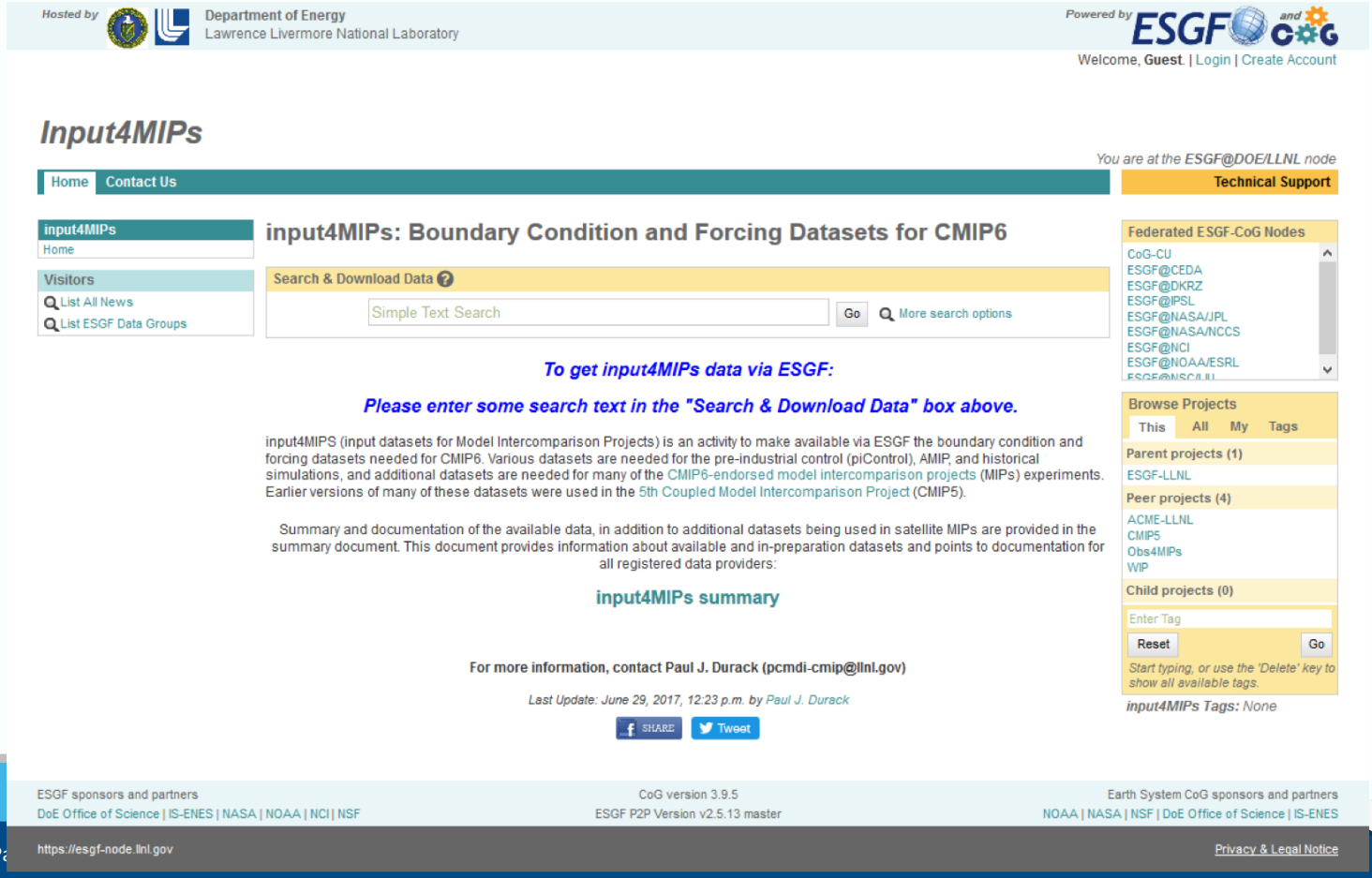
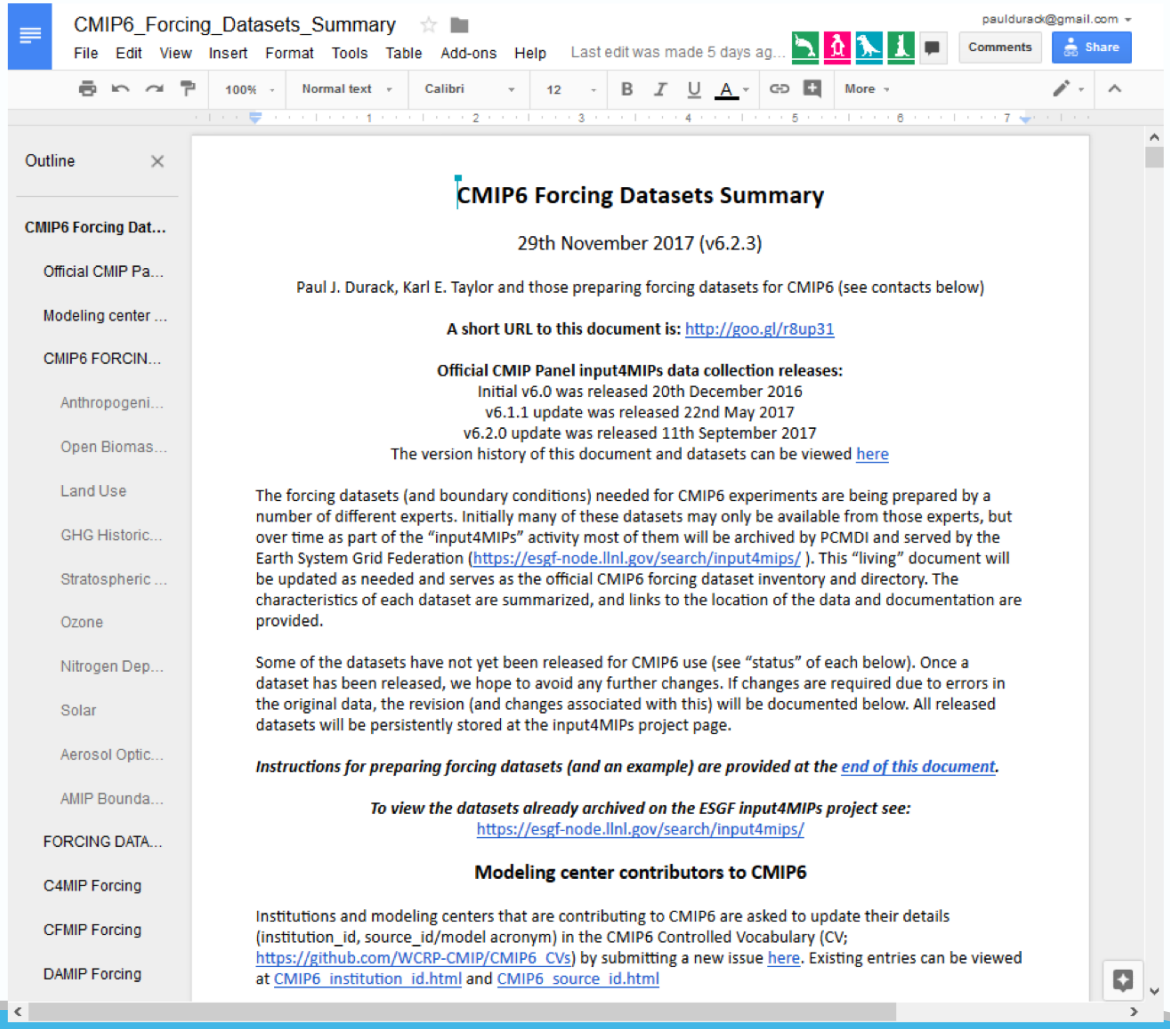
What is input4MIPs:

- **Hosts all required CMIP (DECK) and satellite MIP experiments forcing datasets**
- **Currently ~1200 files, ~0.5TB, ~15 contributing institutions**
- **User base is small ~100 users, ~30+ modeling groups**



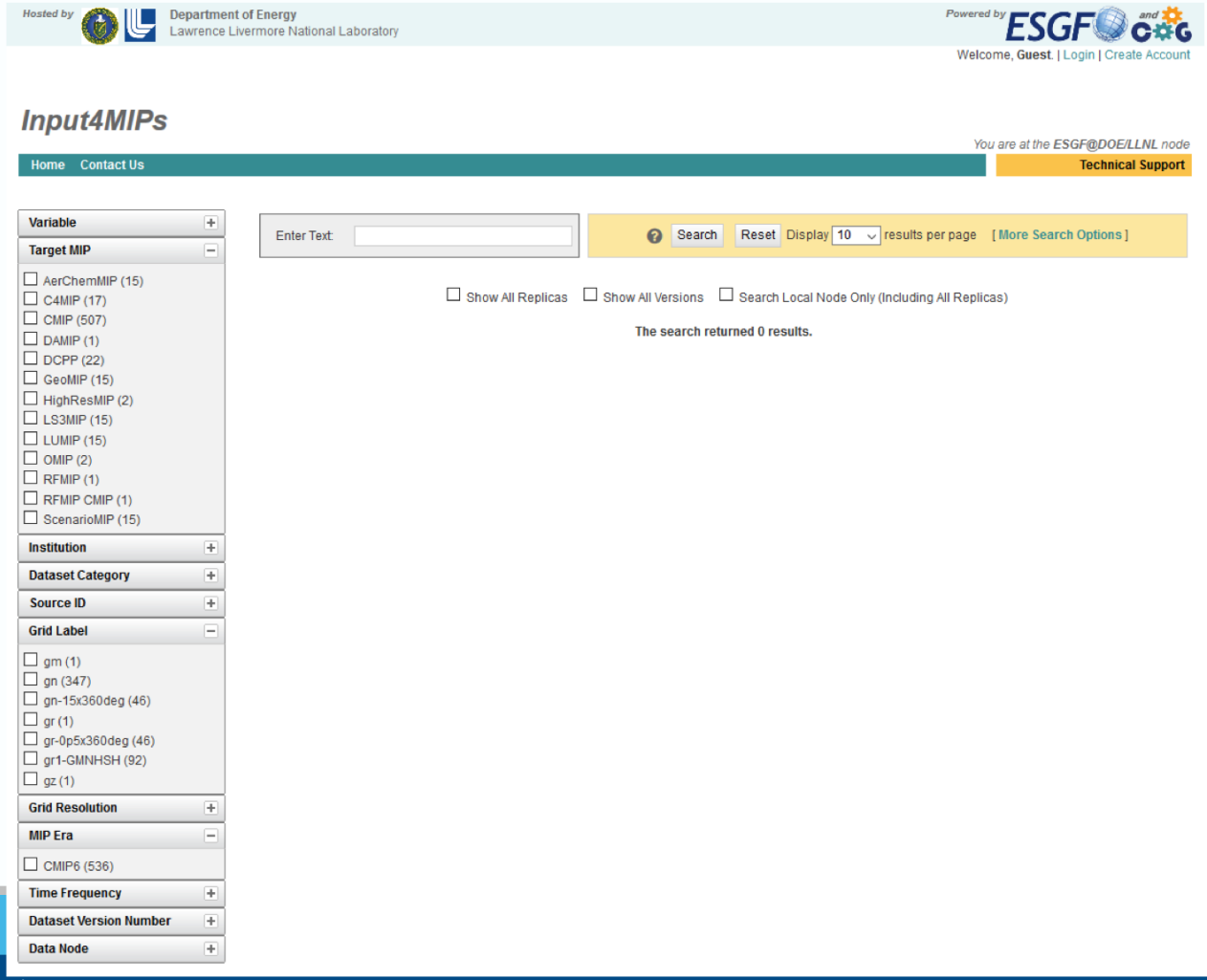
What is input4MIPs:

- **Moving target – using "live" google doc to keep track of changing datasets**



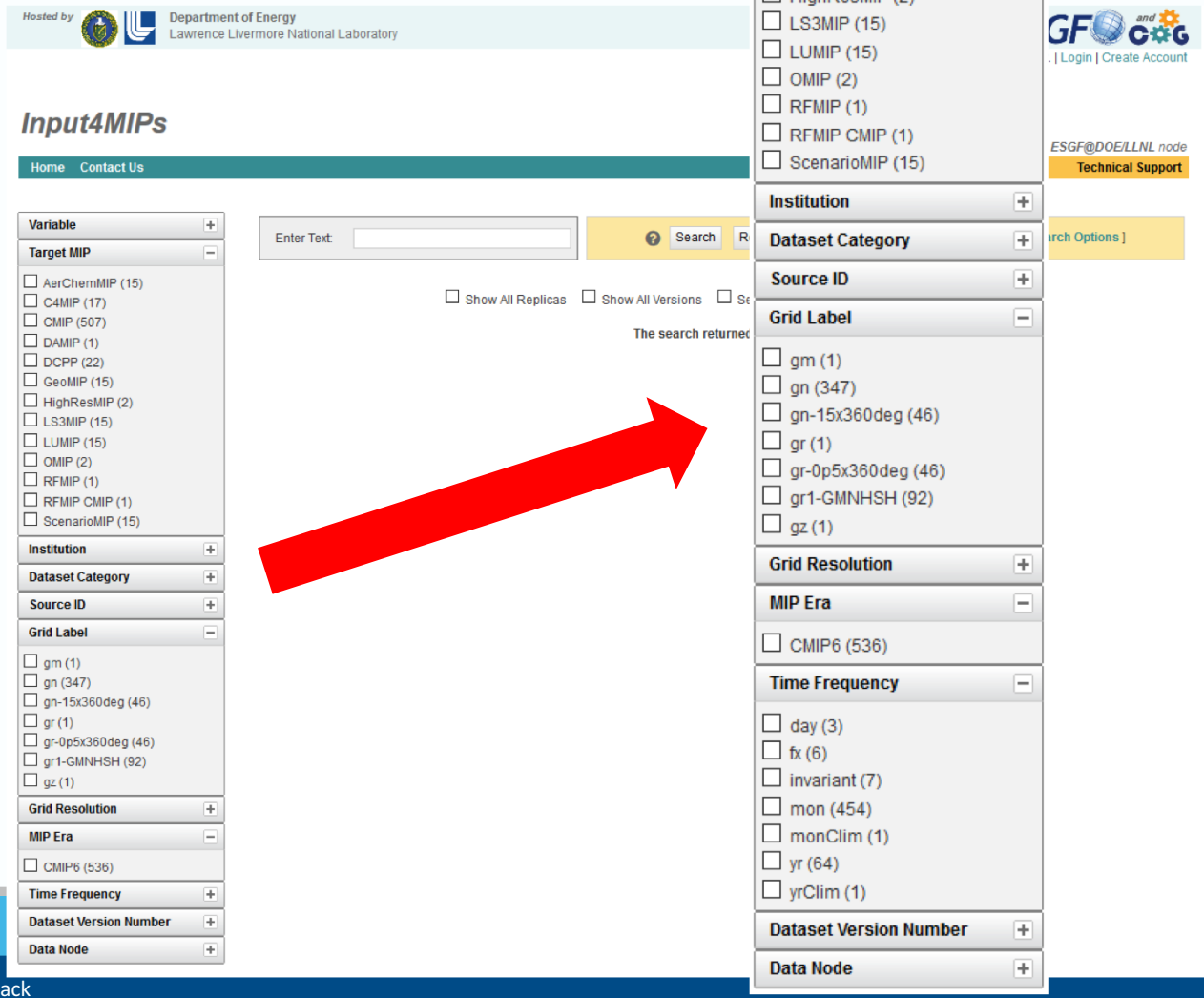
What is input4MIPs:

- **Search facets – have attempted to conform as closely to CMIP6 as possible**
- **Learning-by-doing publication quirks will be fixed in a Jan ‘18 republication**



What is input4MIPs:

- **Search facets – have attempted to conform … MIP6 as possible**
- **Learning-by-doing publication quirks will be … '18 republication**



Section 1:
Problem data
Expanding ESGF support for more data formats

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Problematic data:

- **Large single files vs temporal chunking (1 x 16GB vs 8 x 2GB time chunks)**
- ~16GB (UMD) – user downloads in 3rd world countries

New! LUH2 Historical datasets now available

LUH2 v2h Release (10/14/16): The updated release of the historical land-use forcing dataset (LUH2 v2h) covers the period 850-2015 and corrects all known issues and notices identified with the previous version (LUH2 v1.0h). This dataset replaces the previously released dataset (LUH2 v1.0h). This product is the result of a series of prototypes released previously, uses the established data format, and will connect smoothly to gridded products for the future.

- Historic Data (850 - 2015 AD)
  - states.nc (5.8 GB)
  - transitions.nc (16 GB)
  - management.nc (1.4 GB)
- Supporting Files
  - staticData_quarterdeg.nc (1 MB)
- Data Documentation
  - LUH2_v2h README

- Will large files be an issue for users behind firewalls?
- What is the experience with download restarts with **wget** (**what about rsync**?)

Problematic data:

- **Non-CMIP data: Multiple variables per file (UoM) – rewrite if possible**

```
[durack1@oceanonly CMIP6]$ ncdump -h input4MIPs/UoM/GHGConc/CMIP/yr/atmos/UoM-CMIP-1-1-0/GHGCon
c/gr3-GMNHSH/v20160701/mole_fraction_of_carbon_dioxide_in_air_input4MIPs_GHGConcentrations_CMIP
_UoM-CMIP-1-1-0_gr3-GMNHSH_0000-2014.nc
netcdf mole_fraction_of_carbon_dioxide_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-1-0_
gr3-GMNHSH_0000-2014 {
dimensions:
        lat = 1 ;
        bnds = 2 ;
        time = 2015 ;
variables:
        double lat(lat) ;
                lat:units = "degrees_north" ;
                lat:long_name = "latitude" ;
                lat:standard_name = "latitude" ;
                lat:axis = "Y" ;
                lat:bounds = "lat_bnds" ;
        double lat_bnds(lat, bnds) ;
        double time(time) ;
                time:units = "days since 1850-01-01 00:00:00" ;
                time:calendar = "365_day" ;
                time:long_name = "time" ;
                time:standard_name = "time" ;
                time:axis = "T" ;
                time:bounds = "time_bnds" ;
        double time_bnds(time, bnds) ;
        float carbon_dioxide_GM(time) ;
                carbon_dioxide_GM:long_name = "Global Mean Mole Fraction of CO2" ;
                carbon_dioxide_GM:original_name = "CO2_GM" ;
                carbon_dioxide_GM:standard_name = "mole_fraction_of_carbon_dioxide_in_air" ;
                carbon_dioxide_GM:units = "1.e-6" ;
                carbon_dioxide_GM:cell_methods = "time: mean area: mean" ;
                carbon_dioxide_GM:lat = "0.0" ;
                carbon_dioxide_GM:lat_bnds = "-90.0, 90.0" ;
        float carbon_dioxide_NH(time) ;
                carbon_dioxide_NH:long_name = "Northern Hemisphere Mean Mole Fraction of CO2" ;
                carbon_dioxide_NH:original_name = "CO2_NH" ;
                carbon_dioxide_NH:standard_name = "mole_fraction_of_carbon_dioxide_in_air" ;
                carbon_dioxide_NH:units = "1.e-6" ;
                carbon_dioxide_NH:cell_methods = "time: mean area: mean" ;
                carbon_dioxide_NH:lat = "30.0" ;
                carbon_dioxide_NH:lat_bnds = "0.0, 90.0" ;
        float carbon_dioxide_SH(time) ;
                carbon_dioxide_SH:long_name = "Southern Hemisphere Mean Mole Fraction of CO2" ;
                carbon_dioxide_SH:original_name = "CO2_SH" ;
                carbon_dioxide_SH:standard_name = "mole_fraction_of_carbon_dioxide_in_air" ;
                carbon_dioxide_SH:units = "1.e-6" ;
                carbon_dioxide_SH:cell_methods = "time: mean area: mean" ;
                carbon_dioxide_SH:lat = "-30.0" ;
                carbon_dioxide_SH:lat_bnds = "-90.0, 0.0" ;

// global attributes:
                :title = "UoM-CMIP-1-1-0: historical GHG concentrations: global and hemispheric
 means of CO2 prepared for input4MIPs" ;
                :institution_id = "UoM" ;
                :dataset_category = "GHGConcentrations" ;
                :dataset_version_number = "1.1.0" ;
```

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Problematic data:

- **Non-CMIP data: Multiple variables per file (UoM) – rewrite if possible**

```
[durack1@oceanonly CMIP6]$ ncdump -h input4MIPs/UoM/GHGConc/CMIP/yr/atmos/UoM-CMIP-1-1-0/GHGCon
c/gr3-GMNHSH/v20160701/mole_fraction_of_carbon_dioxide_in_air_input4MIPs_GHGConcentrations_CMIP
_UoM-CMIP-1-1-0_gr3-GMNHSH_0000-2014.nc
netcdf mole_fraction_of_carbon_dioxide_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-1-0_
gr3-GMNHSH_0000-2014 {
dimensions:
        lat = 1 ;
        bnds = 2 ;
        time = 2015 ;
variables:
        double lat(lat) ;
                lat:units = "degrees_north" ;
                lat:long_name = "latitude" ;
                lat:standard_name = "latitude" ;
                lat:axis = "Y" ;
                lat:bounds = "lat_bnds" ;
        double lat_bnds(lat, bnds) ;
        double time(time) ;
                time:units = "days since 1850-01-01 00:00:00" ;
                time:calendar = "365_day" ;
                time:long_name = "time" ;
                time:standard_name = "time" ;
                time:axis = "T" ;
                time:bounds = "time_bnds" ;
        double time_bnds(time, bnds) ;
        float carbon_dioxide_GM(time) ;
                carbon_dioxide_GM:long_name = "Global Mean Mole Fraction of CO
                carbon_dioxide_GM:original_name = "CO2_GM" ;
                carbon_dioxide_GM:standard_name = "mole_fraction_of_carbon_dio
                carbon_dioxide_GM:units = "1.e-6" ;
                carbon_dioxide_GM:cell_methods = "time: mean area:
                carbon_dioxide_GM:lat = "0.0" ;
                carbon_dioxide_GM:lat_bnds = "-90.0, 90.0" ;
        float carbon_dioxide_NH(time) ;
                carbon_dioxide_NH:long_name = "Northern Hemisphere Mean Mole F
                carbon_dioxide_NH:original_name = "CO2_NH" ;
                carbon_dioxide_NH:standard_name = "mole_fraction_of_carbon_dio
                carbon_dioxide_NH:units = "1.e-6" ;
                carbon_dioxide_NH:cell_methods = "time: mean area: mean" ;
                carbon_dioxide_NH:lat = "30.0" ;
                carbon_dioxide_NH:lat_bnds = "0.0, 90.0" ;
        float carbon_dioxide_SH(time) ;
                carbon_dioxide_SH:long_name = "Southern Hemisphere Mean Mole F
                carbon_dioxide_SH:original_name = "CO2_SH" ;
                carbon_dioxide_SH:standard_name = "mole_fraction_of_carbon_dio
                carbon_dioxide_SH:units = "1.e-6" ;
                carbon_dioxide_SH:cell_methods = "time: mean area: mean" ;
                carbon_dioxide_SH:lat = "-30.0" ;
                carbon_dioxide_SH:lat_bnds = "-90.0, 0.0" ;

// global attributes:
                :title = "UoM-CMIP-1-1-0: historical GHG concentrations: global and hemispheric
 means of CO2 prepared for input4MIPs" ;
                :institution_id = "UoM" ;
                :dataset_category = "GHGConcentrations" ;
                :dataset_version_number = "1.1.0" ;
```

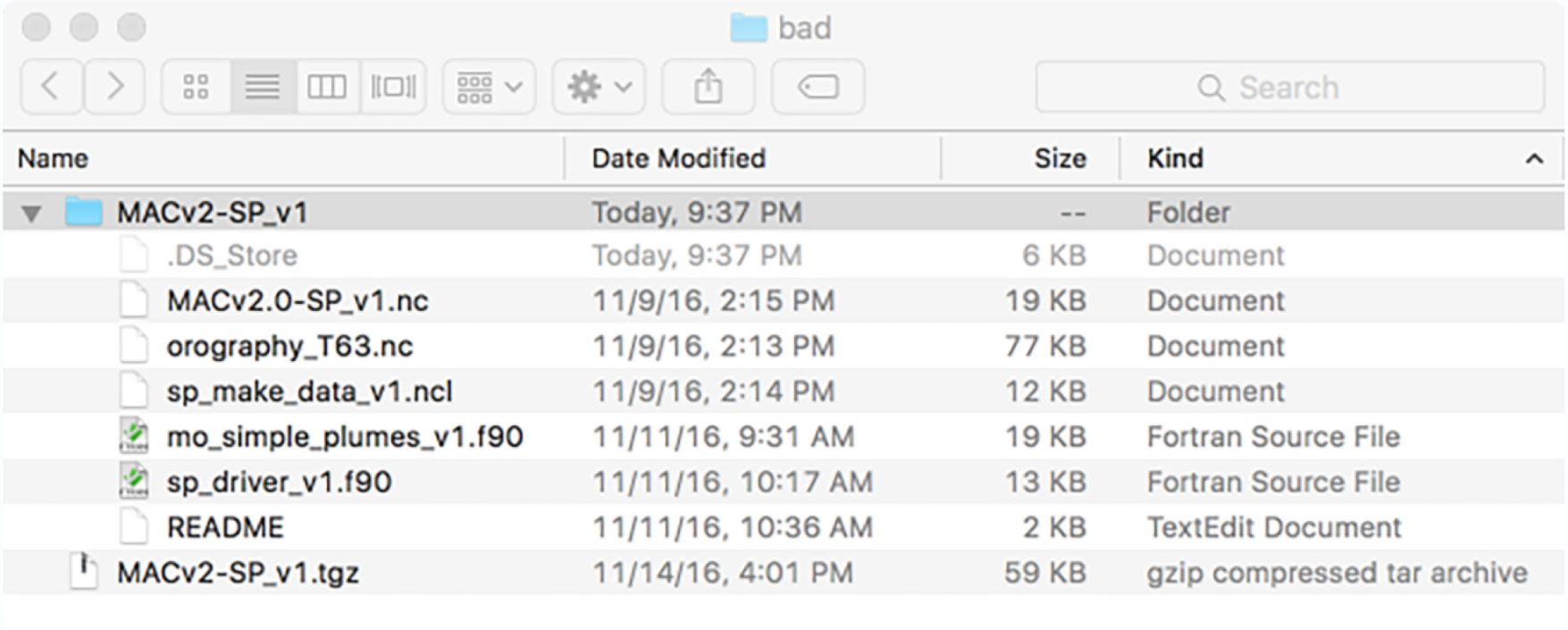
Rewritten file..

```
[durack1@oceanonly CMIP6]$ ncdump -h input4MIPs/UoM/GHGConcentrations/CMIP/yr/atmos/UoM-CMIP-1-
2-0/mole_fraction_of_carbon_dioxide_in_air/gr1-GMNHSH/v20160830/mole_fraction_of_carbon_dioxide
_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_gr1-GMNHSH_0000-2014.nc
netcdf mole_fraction_of_carbon_dioxide_in_air_input4MIPs_GHGConcentrations_CMIP_UoM-CMIP-1-2-0_
gr1-GMNHSH_0000-2014 {
dimensions:
        time = UNLIMITED ; // (2015 currently)
        bound = 2 ;
        sector = 3 ;
variables:
        float time(time) ;
                time:bounds = "time_bnds" ;
                time:long_name = "time" ;
                time:standard_name = "time" ;
                time:units = "days since 0-1-1" ;
                time:calendar = "gregorian" ;
                time:axis = "T" ;
        double time_bnds(time, bound) ;
        int sector(sector) ;
                sector:bounds = "sector_bnds" ;
                sector:lat_bnds = "0: -90.0, 90.0; 1: 0.0, 90.0; 2: -90.0, 0.0" ;
                sector:long_name = "sector" ;
                sector:ids = "0: Global; 1: Northern Hemisphere; 2: Southern Hemisphere" ;
                sector:original_names = "0: CO2_GM; 1: CO2_NH; 2: CO2_SH" ;
        double sector_bnds(sector, bound) ;
        float mole_fraction_of_carbon_dioxide_in_air(time, sector) ;
                mole_fraction_of_carbon_dioxide_in_air:_FillValue = 1.e+20f ;
                mole_fraction_of_carbon_dioxide_in_air:missing_value = 1.e+20f ;
                mole_fraction_of_carbon_dioxide_in_air:long_name = "mole" ;
                mole_fraction_of_carbon_dioxide_in_air:cell_methods = "time: mean area: mean" ;
                mole_fraction_of_carbon_dioxide_in_air:units = "1.e-6" ;

// global attributes:
                :Conventions = "CF-1.6" ;
                :comment = "Data provided are global and hemispheric area-weighted means. Zonal
 means for 15-degree lat bands or 0.5-degree lat bands are available in gn-15x360 or gr-0p5x360
 files respectively" ;
                :variable_id = "mole_fraction_of_carbon_dioxide_in_air" ;
```

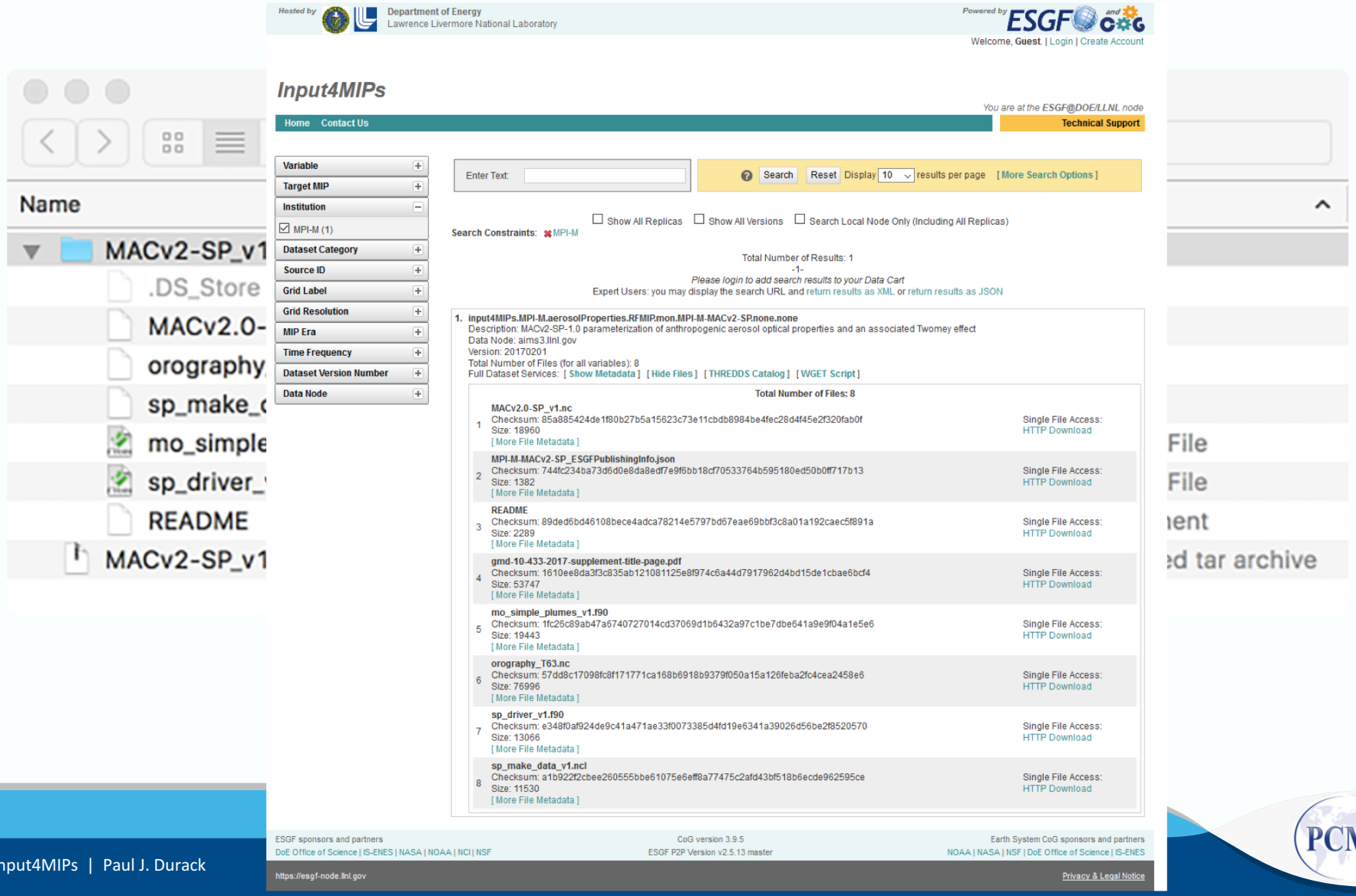
Problematic data:

- **Non-netcdf – tar gzipped, code snippets, text files (MPI)**



Problematic data:

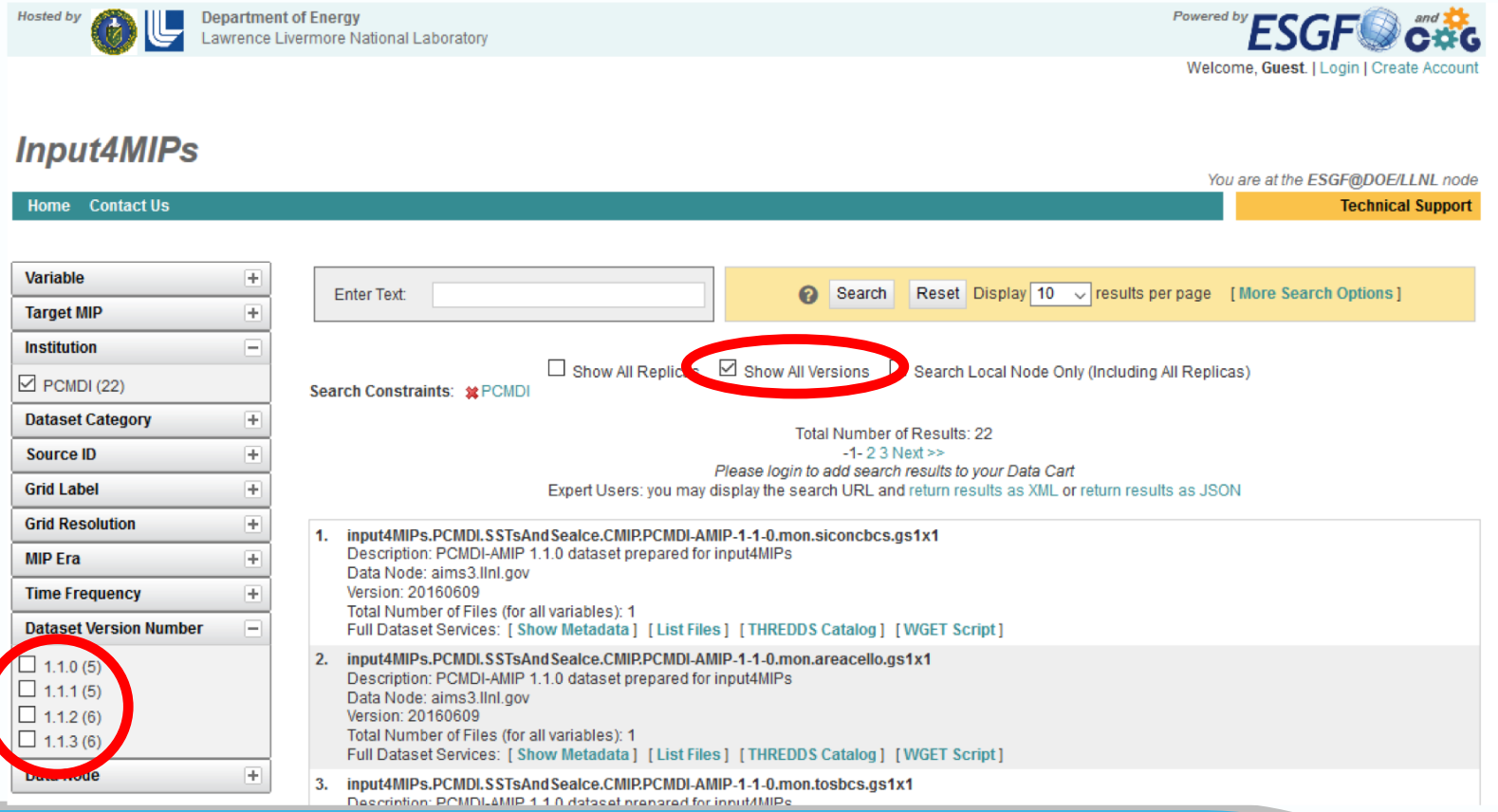
- **Non-netcdf – tar gzipped, code snippets, text files (MPI-M)**



Section 2:
Deprecating datasets
How to gracefully “hide” obsolete datasets, but leave them available for trace-ability

Deprecating datasets (gracefully):

- Useful for datasets that are deprecated (rather than unpublishing)
- PCMDI AMIP dataset is updated every 6 months – `1.1.0` vs `1.1.1` vs `1.1.2` vs `1.1.3`..



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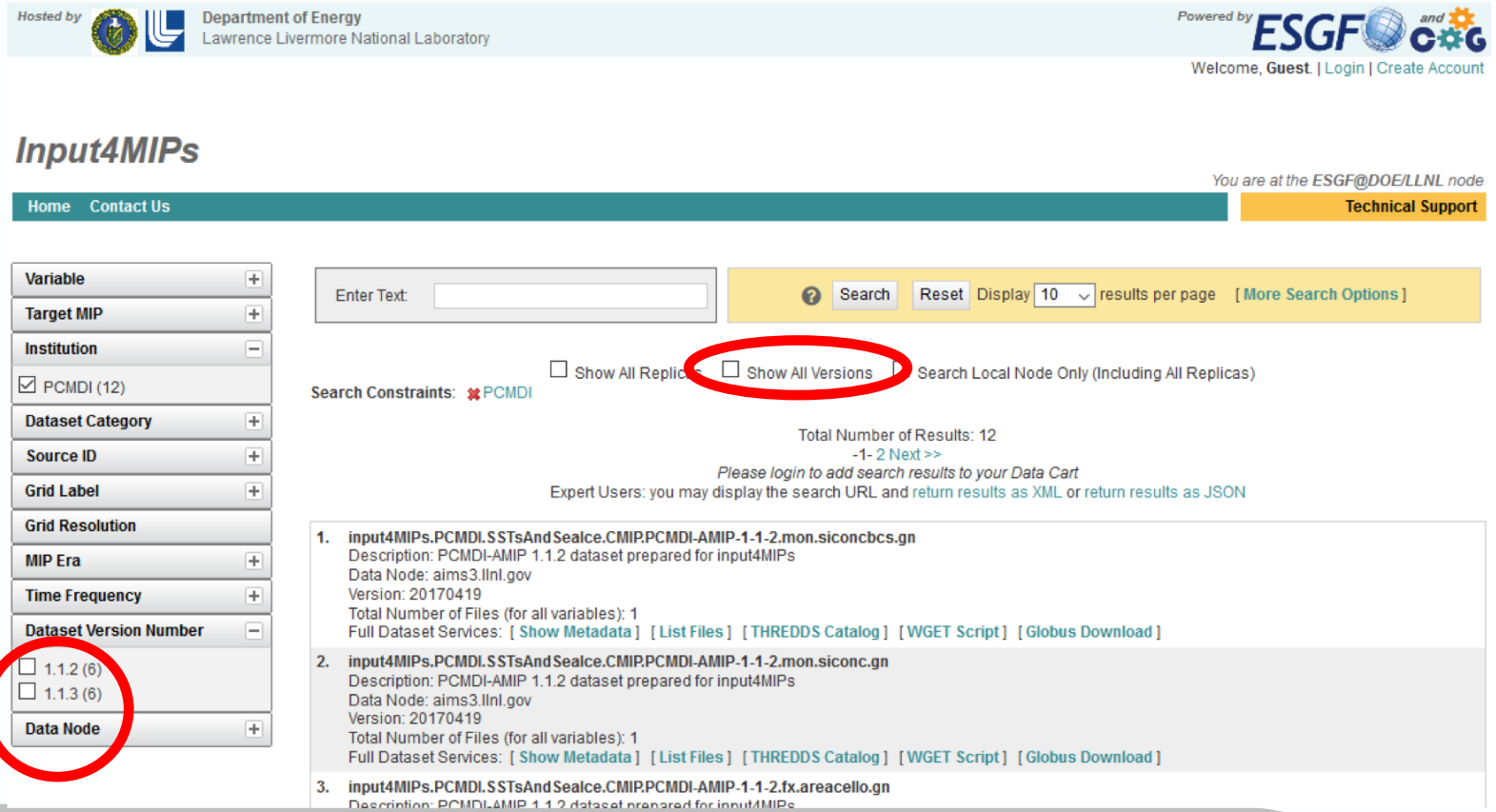

Section 3:
DOI minting and DKRZ citation service

Making contributed data findable and citable

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DKRZ Citation Service active:

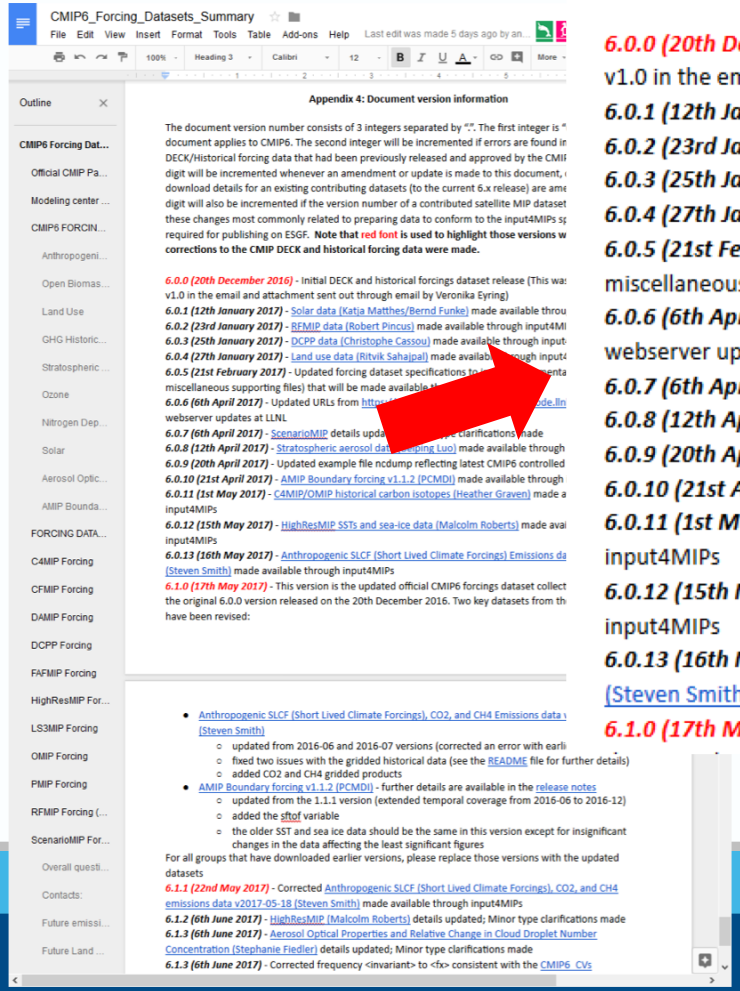
- Useful for dataset discovery and citation - brings recognition to data providers
- PCMDI AMIP dataset is updated every 6 months – `1.1.0` vs `1.1.1` vs `1.1.2` vs `1.1.3`..

http://doi.org/10.22033/ESGF/input4MIPs.1161

Section 4:
Integrated with the ES-DOC model documentation system
Making input4MIPs versioned data correctly citable by modeling groups

Keeping track of data versions:

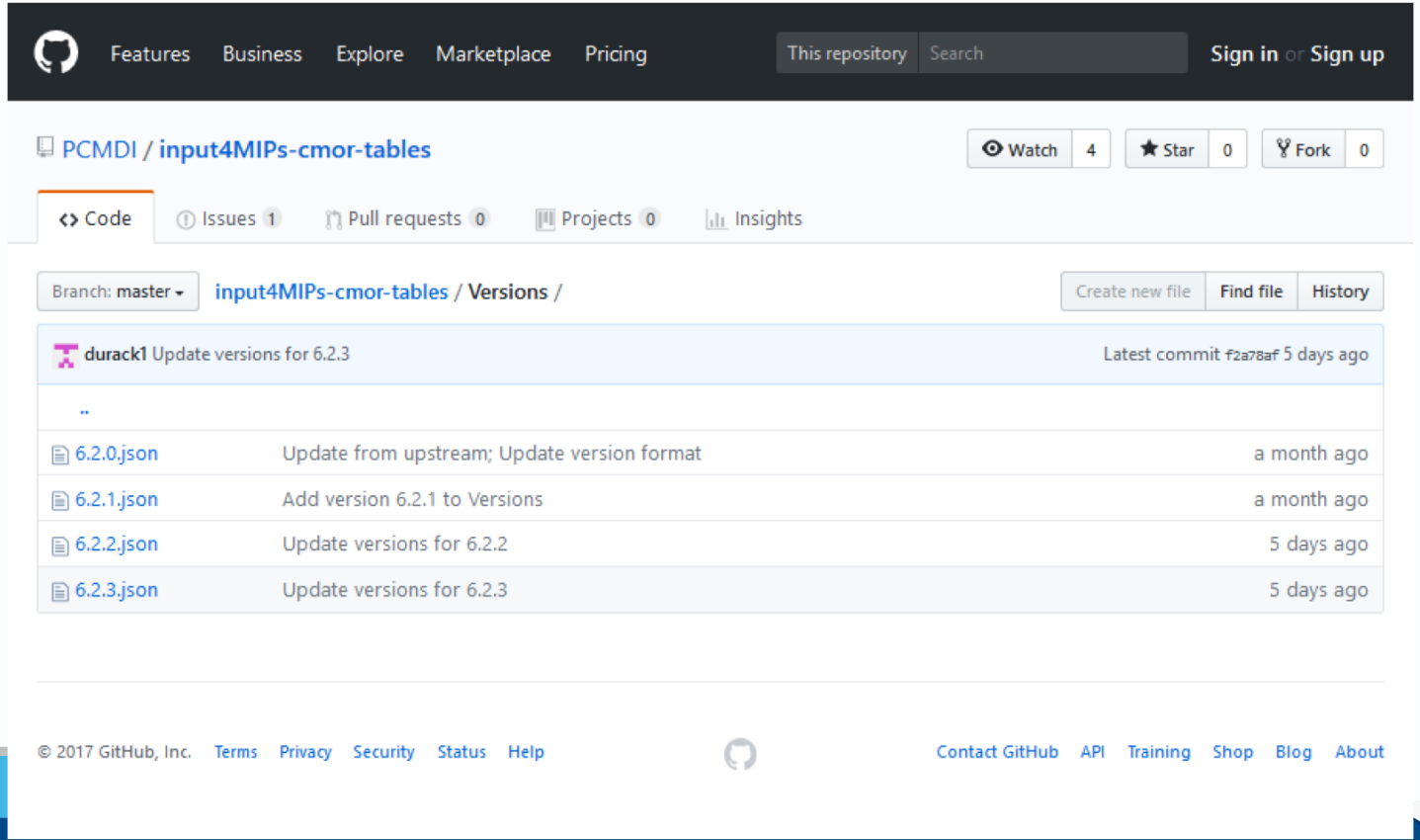
- Contributed datasets have been growing
- Multiple versions since December 2016, with 3 CMIP panel “official” releases and a multitude of updates in between official releases



6.0.0 (20th December 2016) - Initial DECK and historical forcings dataset release (This was also noted as v1.0 in the email and attachment sent out through email by Veronika Eyring)
6.0.1 (12th January 2017) - Solar data (Katja Matthes/Bernd Funke) made available through input4MIPs
6.0.2 (23rd January 2017) - RFMIP data (Robert Pincus) made available through input4MIPs
6.0.3 (25th January 2017) - DCPP data (Christophe Cassou) made available through input4MIPs
6.0.4 (27th January 2017) - Land use data (Ritvik Sahajpal) made available through input4MIPs
6.0.5 (21st February 2017) - Updated forcing dataset specifications to include documentation (and miscellaneous supporting files) that will be made available through input4MIPs
6.0.6 (6th April 2017) - Updated URLs from https://pcmdi.llnl.gov to https://esgf-node.llnl.gov after webserver updates at LLNL
6.0.7 (6th April 2017) - ScenarioMIP details updated; Minor type clarifications made
6.0.8 (12th April 2017) - Stratospheric aerosol data (Beiping Luo) made available through input4MIPs
6.0.9 (20th April 2017) - Updated example file ncdump reflecting latest CMIP6 controlled vocabulary
6.0.10 (21st April 2017) - AMIP Boundary forcing v1.1.2 (PCMDI) made available through input4MIPs
6.0.11 (1st May 2017) - C4MIP/OMIP historical carbon isotopes (Heather Graven) made available through input4MIPs
6.0.12 (15th May 2017) - HighResMIP SSTs and sea-ice data (Malcolm Roberts) made available through input4MIPs
6.0.13 (16th May 2017) - Anthropogenic SLCF (Short Lived Climate Forcings) Emissions data v2017-05-01 (Steven Smith) made available through input4MIPs
6.1.0 (17th May 2017) - This version is the updated official CMIP6 forcings dataset collection. It supersedes

Keeping track of data versions:

- Contributed datasets have been growing
- Multiple versions since December 2016, with 3 CMIP panel “official” releases and a multitude of updates (~27 versions) between official releases
- Attempt to manage version info using json dictionaries for use by ES-DOCs



Section 5:
Ensuring consistent publication metadata across the project

PCMDI

If data doesn't follow identical metadata conventions:

- **Maintaining consistent publication entries is a challenge**

UofMD_yr_UofMD-landState-MAGPIE-ssp585-2-1-f_multiple-transitions.json (~/Desktop) - VIM


```
{
    "input4MIPs-RitvikSahajpal_LandUseForcing":{
        "Conventions":"CF-1.6",
        "activity_id":"input4MIPs",
        "contact":"gchurtt@umd.edu, lchini@umd.edu, steve.frolking@unh.edu, ritvik@umd.edu",
        "creation_date":"2017-09-16T23:15:45Z",
        "dataset_category":"landState",
        "dataset_version_number":"2.1f",
        "file":"CMIP6/input4MIPs/UofMD/landState/ScenarioMIP/yr/land/UofMD-landState-MAGPIE-ss
p585-2-1-f/multiple-transitions/gn/v20171005/multiple-transitions_input4MIPs_landState_Scenari
oMIP_UofMD-MAGPIE-ssp585-2-1-f_gn_2015-2100.nc",
        "frequency":"yr",
        "further_info_url":"http://luh.umd.edu",
        "grid_label":"gn",
        "institution":"University of Maryland (UofMD), College Park, MD 20742, USA",
        "institution_id":"UofMD",
        "mip_era":"CMIP6",
        "nominal_resolution":"25 km",
        "project":"input4MIPs",
        "realm":"land",
        "source":"LUH2 v2.1f: Land-Use Harmonization Data Set",
        "source_id":"UofMD-landState-MAGPIE-ssp585-2-1-f",
        "target_mip":[
            "ScenarioMIP",
            "AerChemMIP",
            "C4MIP",
            "DCPP",
            "GeoMIP",
            "LS3MIP",
            "LUMIP"
        ],
        "timestamp":"2017-10-05T18:29:23Z",
        "title":"UofMD LUH2f dataset prepared for input4MIPs",
        "tracking_id":"hdl:21.14100/c7bb2ffe-a32a-4fb3-b742-196f3bc89661",
        "variable_id":"multiple-transitions",
        "version":"v20171005"
    }
}
```


1,1 All

Section 6:
Replication with SYNDA
Multiple variable files do not conform to CMIP-standards and..

SYNDA replication:

- **SYNDA has hit problems** downloading input4MIPs data with more than a single variable per file
- **Contributed data passed the CF-check**, but isn't CMIP "format" single variable per file
- **input4MIPs data isn't derived from models**, the **DRS structure differs** from the CMIP data
- Many of the "obs" **products contributed have interacting variables – to use the data you need more than a single variable in memory**
- ***esg.ini configuration changes seem to have solved the issue**

Thank you

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